44. (New) The system of claim 42 wherein the processor forms a two-dimensional image from the plurality of one-spatial-dimensional spectral images, and derives the measurement from spectral information obtained from the two-dimensional image.

Sub B16

45. (New) The system of claim 44 wherein the processor analyzes the two-dimensional image to find one or more predetermined measurement locations, and derives one or more measurements from spectral information obtained from the two-dimensional image at the one or more predetermined measurement locations.

Cont 4

46. (New) The method of claim 43 wherein the second deriving step further comprises forming a two-dimensional image from the plurality of one-spatial-dimension spectral images, and deriving the measurement from spectral information obtained from the two-dimensional image.

47. (New) The method of claim 46 wherein the second deriving step further comprises analyzing the two-dimensional image to find one or more predetermined measurement locations, and deriving one or more measurements from spectral information obtained from the two-dimensional image at the one or more predetermined measurement locations.

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REMARKS

Claims 1-47 are in the application. Claims 1, 2, 3, 6, 11, 18, 21, 25, 26, 27 and 30 are amended in this Response. Claims 37-47 are new.

In pars. 1-3 of the Office Action, claims 6, 15, 18-21, 25 and 34 are rejected for lack of novelty of Rohr. However, Applicant respectfully submits that this rejection is not sustainable since each of these claims requires or recites one or more limitations which are unmet by Rohr.

More specifically, each of these claims recites or requires producing a <u>plurality</u> of one-spatial-dimension spectral images from light <u>reflected from or transmitted through a region of a sample</u>, and deriving measurements of <u>film</u> properties from this information.

In contrast to this, in Rohr, only a <u>single</u> image of a volume slice is captured. There is no teaching or disclosure of capturing a <u>plurality</u> of images representative of the volume slice.

Moreover, in Rohr, the image is not formed from light <u>reflected from or transmitted by the material T</u>. Instead, the light from the laser P, which impinges on the material T, forms a plasma PA. The image is then formed from light emitted by this plasma. This light, however, is

distinct from the light from the laser P which impinges on the material T, and cannot reasonably be viewed as corresponding to light reflected from or transmitted through a sample.

Furthermore, in Rohr, the image is used to determine the halogen content of the material T. It is not used to measure a film property.

Because of these profound differences, the lack of novelty rejection of claims 6, 15, 18-21, 25 and 34 cannot stand.

Several of these claims recite or require even more limitations which distinguish over Rohr. Consequently, the lack of novelty rejection based on Rohr is untenable for these additional reasons.

For example, claim 20 requires that the plurality of one-dimensional images which are formed be combined to form a two-dimensional image.

In contrast to this, in Rohr, a plurality of one-dimensional images is not even formed, much less a two-dimensional image derived from the plurality of one-dimensional images.

In addition, claim 21 requires analyzing the two-dimensional image to locate one or more predetermined measurement locations, and then determining one or more film properties at one or more of these predetermined locations.

In contrast to this, there is no teaching or suggestion in Rohr of employing a two-dimensional image, formed from a plurality of one-dimensional images, to find one or more predetermined measurement locations, and then measuring film properties at one or more of the predetermined locations.

For these additional reasons, the lack of novelty rejection of claims 20 and 21 cannot stand.

In pars. 3-4 of the Office Action, claims 1-5, 7-14, 16-17, 22-24, 26-33, and 35-36 are rejected for obviousness over Rohr in view of Kokubo. According to the Examiner, one of ordinary skill in the art would have added the XY stage of Kokubo to Rohr to result in a system which meets the limitations of the claims.

Applicant cannot agree since Rohr, as discussed previously, discloses a system which produces a single image of a volume slice of a plasma, rather than a plurality of images. Furthermore, Kokubo employs a single spot scanner, and the stated purpose of the XY stage of Kokubo is simply to position the sample during a setup mode of operation, not move the scanner

while in a processing mode of operation. See Col. 5, lines 57-58, which states: "The XY stage is moved in an X-direction and a Y-direction as it mounts the sample SP, in order to position an optional region of a surface of the sample SP at the illumination area IA." (Emphasis added). There is no teaching or suggestion in Kokubo of using this XY stage to capture a plurality of images from the sample SP. The lack of such a suggestion is fatal to the obviousness rejection. As the Federal Circuit stated in ACS Hospital Systems, Inc. v. Montefiore Hospital, 221 USPQ 929 (Fed. Cir. 1984): "Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the combination. Under section 103, teachings of references can be combined only if there is some suggestion or incentive to do so." (Emphasis in original). To hold otherwise is to engage in impermissible hindsight reconstruction of the invention using the claims as a blueprint. See, e.g., W.L. Gore & Associates, Inc. v. Garlock, Inc., 220 USPQ 303, 312-13 (Fed. Cir. 1983), cert. denied, 469 U.S. 851 (1984) ("To imbue one of ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher.").

Since a limitation recited or required in each of claims 1-5, 7-14, 16-17, 22-24, 26-33, and 35-36, namely, that a plurality of one-dimensional images by captured from the sample, would be unmet by the resulting system, and Rohr's teachings are wholly deficient as discussed above in relation to several other limitations, the obviousness rejection based on the combination of Rohr and Kokubo is not sustainable.

Furthermore, several of the claims recite or require even more limitations which would be unmet by such a system. Applicant respectfully submits the obviousness rejection cannot stand for these additional reasons.

For example, claims 10 and 29 require formation of a two-dimensional image from the plurality of one-dimensional images, and claims 3, 11 and 30 require analyzing the two-dimensional image to find one or more predetermined measurement locations, and determining measurements of film properties at these one or more predetermined locations. Neither requirement would be met by the resulting system.

Similarly, claims 4, 13-14, 23-24, and 32-33 require or recite measuring additional film properties beside film thickness, such as optical constants and doping density. In contrast to this, Kokubo is only concerned with film thickness, and Rohr is silent on the measurement of film properties.

For these additional reasons, the obviousness rejection of claims 3-4, 10-11, 13-14, 23-24, 29-30, and 32-33 cannot stand.

At par. 5 of the Office Action, claims 1-36 are rejected for obviousness over Kobuko in view of the ImSpector brochure. According to the Examiner, one of ordinary skill would have replaced the imager of Kokubo with the ImSpector, and the resulting system would have met all the limitations of the claims.

Applicant cannot agree since there is absolutely no suggestion in the prior art of applying the ImSpector to the field of semiconductor thin film processing; and even if the two were theoretically combined, the resulting system would not have met the limitations of the claims.

To establish the first point, Applicant has attached the Declaration of Charles Hannes, who has significant expertise in the area of thin film measurement systems, has no affiliation with Filmetrics, Inc., the owner by assignment of the present application, and was involved in efforts to design and develop high throughput thin film measurement systems in the 1990s. (Hannes Decl. ¶¶3-6, 19).

As Mr. Hannes states, there would have been no motivation to apply the ImSpector to the field of semiconductor processing because, based on the data sheet for the ImSpector cited by the Examiner, the ImSpector suffers from one or more performance limitations which would have made it impractical to employ for the purpose of semiconductor processing. (Hannes Decl. ¶9). Consequently, Mr. Hannes believes it would not have been obvious to employ the ImSpector in the Kokubo system. (Id.)

More specifically, according to Mr. Hannes, in the field of semiconductor processing, as of July 6, 2000, it would have been necessary to scan at a resolution of 50 microns or less in order to guarantee measurement of 100 micron features. (Hannes Decla. ¶9). Moreover, it would have been necessary to scan a typical 8 inch wafer in about 10 seconds or less in order to allow integrated circuit manufacturers to measure every wafer without reducing manufacturing

throughput significantly. (Id.) Still further, the component cost of making such an imager should not have exceeded about $20,000 to have remained competitive from a price standpoint. (Id.)

Yet, according to Mr. Hannes, to scan a full line of an 8 inch wafer at the desired resolution of 50 micron or less with the ImSpector, requires that 31 of such devices be placed side-by-side. (Hannes Decl. ¶11). That is because a full line of an 8 inch wafer represents about 4,000 picture elements (pixels) at a resolution of 50 micron, while a single ImSpector can only capture about 130 pixels in such a line. (Id.) Thus, about 31 ImSpectors would have to have been placed side-by-side to have simultaneously captured a line extending across the full width of an 8 inch wafer. (Id.) This would not only have been unduly complex to implement, but it would have been prohibitively expensive. (Id.) In this regard, Mr. Hannes understands that an arrangement of 31 ImSpectors would have cost about $125,000. (Id.) This number far exceeds the acceptable budget (about $20,000) for this component of the system. (Id.)

Moreover, even assuming this side-by-side arrangement could have been implemented, as Mr. Hannes states, it would still have been too slow to have been competitive with other equipment that was then available. (Hannes Decl. ¶12). More specifically, assuming data captured by this arrangement could gave been clocked out at 60 frames/second, about 67 seconds would have been required to scan the entire area of the wafer. (Id.) That is because the length of the wafer also represents about 4000 pixels, and 4000 pixels/60 frames/second is about 67 seconds. (Id.) This far exceeds the 10 second per wafer figure which would have been needed to be practical. (Id.)

Therefore, because of these speed, cost and resolution related limitations, according to Mr. Hannes, as of July 6, 2000, one of ordinary skill in the field of semiconductor processing would not have considered replacing the single spot imager in conventional semiconductor processing equipment with the ImSpector. (Hannes Decl. ¶13).

Mr. Hannes is aware of the Examiner's assertion that the reference in the ImSpector data sheet to "surface inspection" purportedly suggests using the ImSpector in a conventional single spot semiconducor processing system. However, according to Mr. Hannes, the reference in the ImSpector data sheet to "surface inspection" does not refer to semiconductor surface inspection. (Hannes Decl. ¶14). Instead, as Mr. Hannes notes, the reference is to web and surface inspection for "textile, interior material and graphics are production." (Id.) These are all low resolution and

low speed applications which rely on relatively low-level analysis (such as measuring the color of fabric), and are fundamentally different from a high resolution and high throughput application such as semiconductor thin-film analysis, which consists of much more complex and quantitative data processing. (Id.) Therefore, Applicant submits that this reference in the ImSpector data sheet cannot provide the necessary suggestion to use the ImSpector in a conventional single spot system, particularly in light of the performance limitations of the ImSpector.

The Hannes declaration establishes that the invention also fulfills a long-felt but previously unmet need for high throughput thin film processing systems, and that, prior to the invention, no one had thought to apply a one-dimensional imager to thin film processing systems. (Hannes Decla. ¶¶15-19). Such evidence of long-felt but unmet need/failure of others is a well recognized secondary indicia of non-obviousness, In re Piasecki, 223 USPQ 785, 790 (Fed. Cir. 1984), and must be given due weight during the patent examination stage. Id. (affidavits showing long-felt but unfilled need must be given "fair weight" during patent examination process); In re Sernaker, 702 F.2d 989, 996 (Fed. Cir. 1983) (If presented, Board must "always consider such evidence is connection with the determination of obviousness.").

As Mr. Hannes states, since the later 1970s, when integrated semiconductor chips began to be widely used in consumer electronic devices, there has been a demand by semiconductor manufacturers to increase the throughput of semiconductor processing equipment. (Hannes Decla. at ¶15). The reason is that the cost of manufacturing semiconductor chips is directly related to the equipment. (Id.) The higher the throughput, the lower the cost of manufacturing, and the lower the throughput, the higher the cost of manufacturing. (Id.)

According to Mr. Hannes, the demand for increased throughput became particularly acute in the early 1990s due to the escalating cost of semiconductor processing equipment and the smaller minimum device geometries (1 micron) that were then possible. (Hannes Decla. at ¶16). Smaller device geometries entail greater chip densities, more layers per chip, and hence longer manufacturing times. (Id.) Higher throughput processing equipment produces a greater volume of semiconductor chips in a given amount of time. (Id.) Semiconductor chip manufacturers demanded the higher throughput equipment since the greater volume of production could be used to offset the higher equipment cost and the longer manufacturing times that were being experienced. (Id.)

Throughout the 1990s, the demand for higher throughput equipment increased as device geometries decreased and the manufacturing times increased. (Hannes Decla. at ¶17). In 1994, for example, minimum device geometries had decreased to .8 micron. (Id.) By 1998, the figure had decreased to .35 micron. (Id.) Presently, companies such as Intel are manufacturing devices with geometries as low as .09 micron. (Id.) Throughput this time period, the throughput of semiconductor processing equipment steadily increased from 30 wafers per hour to up to 360 wafers per hour, which translates into a processing time of 10 seconds per wafer. (Id.)

To meet the demand for increased throughput, manufacturers and developers of thin-film measurement equipment that is used in semiconductor processing have, according to Mr. Hannes, focused principally on increasing the speed of conventional technology in which a single spot is successively scanned over the surface of the wafer, such as be using faster mirrors and X-Y stages to increase the speed at which the spot travels across the surface of the wafer. (Hannes Decla. at ¶18).

However, Mr. Hannes believes that, until the present application, no one had thought to meet the increasing demand for throughput by employing a one-spatial-dimension/one-spectral-dimension spectroscopic imager in the field of semiconductor processing despite the fact that such a device allows for a fundamental increase in throughput because it allows successive one-dimensional images to be captured from the surface of the wafer instead of just spots. (Id.) Thus, the surface of the wafer can be traversed much more rapidly than with a single spot scanner. According to Mr. Hannes, the fact that no one, until the filing of the subject application, had thought to use these imagers in the field of semiconductor processing, despite the strong demand for increased throughput, is strong evidence of the non-obviousness of employing such devices in the field of semiconductor processing. (Id.)

As an example, as Mr. Hannes points out, consider that, in the 1990s, work was underway at Hughes Aircraft Company to develop systems for measuring the thickness of thin-films on semiconductor wafers. (Hannes Decla. at ¶19). Such work is represented by Ledger, U.S. Patent No. 5,291,269 (the '269 patent), a copy of which is attached hereto as Exhibit A. (Id.) Yet, at about the same time, work was also underway at an affiliate of Hughes, known as Hughes Danbury Optical Systems, Inc., to use an imaging sensor, analogous to the ImSpector and known as a "pushbroom" imaging sensor, for airborne measurements of the earth's surface. (Id.) Such

work is represented by R. W. Basedow, "Hydice: Operational System Status," NASA, ISSSR-95, a copy of which is attached hereto as Exhibit B. (Id.) Even though both efforts were underway at the time within affiliates of Hughes, no one thought to apply the pushbroom imaging sensor to semiconductor processing. (Id.) In fact, Mr. Hannes personally worked with Anthony Ledger, the named inventor of the '269 patent, in this time frame at the Hughes Danbury facility in an effort to develop and design high throughput thin-film measurement equipment. (Id.) Both were employed at the time by IPEC, which had purchased the portion of the Hughes Danbury facility involved with the development of thin-film measurement equipment. (Id.) Neither Mr. Hannes or Mr. Ledger, nor anyone else on the development team, had thought to apply the pushbroom imaging sensor to the area of thin-film measurement. (Id.)

Therefore, the lack of any suggestion or motivation in the prior art to apply an imager such as the ImSpector to semiconductor thin film processing, and the evidence of long-felt but unfilled need and failure of others, is fatal to the obviousness rejection based on the combination of Kokubo and the ImSpector.

An additional infirmity of this obviousness rejection is that, even if it were theoretically possible to add the ImSpector to Kokubo, the resulting system would not meet limitations recited or required by the claims.

For example, each of claims 1-36 requires obtaining a plurality of one-dimensional images from the sample. Yet, the purpose of the XY stage in Kokubo is to position the sample during a setup mode of operation, not obtain a plurality of images during a processing mode of operation. Thus, this requirement would be unmet by the resulting system.

Moreover, claims 10 and 29 require formation of a two-dimensional image from the plurality of one-dimensional images, and claims 3, 11 and 30 require analyzing the two-dimensional image to find one or more predetermined measurement locations, and determining measurements of film properties at these one or more predetermined locations. Neither requirement would be met by the resulting system.

Furthermore, claims 4, 13-14, 23-24, and 32-33 require or recite measuring additional film properties beside film thickness. Such a requirement would be unmet by the resulting system.

Therefore, Applicant respectfully submits that the obviousness rejection of claims 1-36 based on Kokubo in view of the ImSpector brochure cannot stand.

New claims 37-47 patentably distinguish over the cited references for the same or similar reasons as claims 1-36.

For all the foregoing reasons, the Examiner is earnestly solicited to allow all claims and pass this application to issuance.

Applicant has enclosed with this Response a petition for a two-month extension, extending the time period for response through December 9, 2002. Authorization to charge our Deposit Account for the extension fee is set forth in that petition.

The Commissioner is hereby authorized to charge Howrey Deposit Account No. 08-3038 for the excess claims fee, due to the addition herein of new claims, referencing Howrey Dkt. No. 02578.0006.00US00. Applicant believes no other fees are due. However, if in fact such fees are due, the Commissioner is authorized to charge the same to Howrey Deposit Account No. 08-3038 referencing Howrey Dkt. No. 02578.0006.00US00.

Respectfully submitted,

Date: December 9, 2002

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the application of:

SCOTT A. CHALMERS, ET AL.

Application No.: **09/611,219**

Filed: **July 6, 2000**

For: **METHOD AND APPARATUS FOR HIGH-SPEED THICKNESS MAPPING OF PATTERNED THIN FILMS**

Art Unit: 2877

Examiner: Hoa Q Pham

MARKED UP VERSION

In accordance with 37 C.F.R. §§1.121(b)(1)(iii), a marked up version of the prior pending claims, with all changes shown by the previously used convention comparison system (deletions in brackets, insertions underlined) follows:

1. (Once Amended) A film measurement apparatus comprising:

a light source configured to generate a light signal;

[a fiber optic cable connected to said light source to receive said light signal and further configured to direct]<u>means for directing</u> said light signal onto a sample to obtain a reflected <u>or transmitted</u> light signal having a plurality of wavelength components, each having an intensity;

a one-spatial-dimension imaging spectrometer configured to receive said reflected <u>or transmitted</u> light signal, and derive therefrom <u>a one-spatial-dimension spectral image comprising, for each of one or more locations represented by the image,</u> a plurality of electrical signals, each representative of the intensity of a wavelength component of the reflected <u>or transmitted</u> light <u>at the location</u>;

CERTIFICATE OF MAILING
(37 C.F.R. §1.8a)

I hereby certify that this paper (along with any referred to as being attached hereto) is being deposited with the United States Postal Service on the date shown below with sufficient postage as First Class Mail in an envelope addressed to the Commissioner for Patents, Washington, D.C. 20231.

December 9, 2002
Date of Deposit

Robin L. Clow
Name of Person Mailing Paper

R. Clow
Signature of Person Mailing Paper

a translation mechanism to [scan]relatively translate the [measured]sample [under]relative to the [one-spatial-dimension imaging spectrometer]light source; and

a computer configured to control the translation mechanism to relatively translate the sample relative to the light source so that [receive from]said one-spatial-dimension imaging spectrometer [said plurality of electrical signals]produces a plurality of one-spatial-dimension spectral images, and the computer is further configured to [determine therefrom the thickness] derive a measurement of at least one property of at least one film [on]of said sample from spectral information obtained from said plurality of one-spatial dimension spectral images[, by:

obtaining data representative of the intensity of at least some of said wavelength components by scanning the sample with the said one-spatial-dimension imaging spectrometer;

arranging said data so that two-spatial-dimension image is formed;

analyzing at least one wavelength component of the said two-spatial-dimension spectral image to find one or more pre-determined measurement locations; and

providing a measurement of the thickness of one or more layers in at least one region of the sample by analyzing the spectral reflectance data obtained from that region].

2. (Once Amended) The apparatus of claim 1 [in which the scanning motion of the one-spatial-dimension spectroscopic imager relative to the sample is provided by moving the one-dimensional spectroscopic imager]in which the translation mechanism moves the sample relative to the light source.

3. (Once Amended) The apparatus of claim 1 [where the measurement locations are determined by analyzing the spectral data]wherein the computer is configured to form a two-spatial-dimensional image from the plurality of one-spatial-dimensional images, analyze the two-dimensional image to find one or more predetermined measurement locations, and measure one or more film properties from spectral information obtained at the one or more predetermined locations.

6. (Once Amended) A film measurement apparatus comprising:

a light source configured to generate a light signal;

a one-spatial-dimension imaging spectrometer configured to receive light from said light source that has been reflected or transmitted by a sample, and derive therefrom a one-spatial-dimension spectral image comprising, for each of one or more locations represented by the

image, a plurality of signals, each signal representative of the intensity of a wavelength component of the reflected or transmitted light at [a particular]the location; and

a computer configured to receive from said one-spatial-dimension imaging spectrometer [said plurality of signals]a plurality of one-spatial-dimension spectral images representative of a region of the sample, and derive, from spectral information obtained from the plurality of one-spatial-dimension spectral images, [determine therefrom the]a measurement of one or more properties of at least one film [in at least one region]of said sample[by analyzing the spectral data obtained from that region].

11. (Once Amended) The apparatus of claim 10 wherein at least one wavelength component of [the]said two-spatial-dimension spectral image is analyzed to find one or more pre-determined measurement locations, and measurements of one or more film properties are derived from spectral information obtained at the one or more pre-determined measurement locations.

18. (Once Amended) A method [for]of measuring [the]one or more properties of [a]at least one film [on]of a sample by:

forming a [line]plurality of one-spatial-dimension spectral images, representative of a region of the sample, from light reflected off of or transmitted through [a corresponding region of]the sample, each image comprising, for each of one or more locations represented by the image, a plurality of signals, each representative of a wavelength component of the reflected or transmitted light at the location;

[individually dissecting one or more subportions of the line mage into relevant constituent wavelength components, thereby forming a spectral line image;] and

[individually analyzing the resultant spectral data representative of the relevant constituent wavelength components of the one or more subportions to determine]analyzing spectral data obtained from the plurality of one-spatial-dimension spectral images to determine a measurement of one or more properties of the film.

21. (Once Amended) The method of claim 20 further comprising determining one or more measurement locations from the two-spatial-dimension spectral image of the sample, and deriving a measurement of one or more properties of one or more films of the sample from spectral information obtained from one or more of the measurement locations.

25. (Once Amended) A film measurement system comprising:

a light source configured to generate a light signal;

a one-spatial-dimension imaging spectrometer configured to receive light from said light source that has been reflected or transmitted by a sample, and derive therefrom a one-spatial-dimension spectral image comprising, for each of one or more locations represented by the image, a plurality of signals, each signal representative of the intensity of a wavelength component of the reflected or transmitted light at [a particular]the location; and

a computer configured to receive from said one-spatial-dimension imaging spectrometer [said plurality of signals]a plurality of one-spatial-dimension spectral images representative of a region of the sample, and [determine therefrom]derive, from spectral data obtained from the plurality of images, [the]a measurement of one or more properties of at least one film [in at least one region]of said sample[, by analyzing the spectral data obtained from that region].

26. (Once Amended) The system of claim 25 [where a]further comprising a translation mechanism which is used to move the [measured]sample relative to the [one-spatial-dimension imaging spectrometer]light source to obtain a series of one-spatial-dimension spectral images of a region of the sample.

27. (Once Amended) The system of claim 25 [where a]further comprising a translation mechanism which is used to move the [one-spatial-dimension imaging spectrometer]light source relative to the [measured]sample to obtain a series of one-spatial-dimension spectral images of a region of the sample.

30. (Once Amended) The system of claim 29 where at least one wavelength component of [the]said two-spatial-dimension spectral image is analyzed to find one or more pre-determined measurement locations, and measurements of one or more film properties are derived from spectral information obtained at the one or more pre-determined measurement locations.

Respectfully submitted,

Date: December 9, 2002

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